National Air Disaster Alliance/Foundation (NADA/F) Questions and Comments Through ARAC Ex-Com on the June 2001 FTIHWG Final Report

Question 1

1.) Within the report as submitted there are significant omissions which must be addressed:

a) A literature survey is required in order to identify all significant documents pertaining to fuel tank flammability, explosions, and ignition sources.

Response:
Bill Kauffman, a Working Group member and Ex. Com. member, has provided a list of references:

#1. AAR, File# 1-0015, 3 March 65, CAB, Boeing 707-121, N709 PA, Pan American World Airways, Inc, near Elkton MD, 8 Dec, 1963.

#2. FAA-RD-72-53, The Performance of a DC-9 Aircraft Liquid Nitrogen Fuel Tank Inerting System, Aug. 1972, final report, DOT, FAA.

#3. The Boeing Co, Code Ident. No D226-20582-1, Vol. 1 of 4, Center Wing Tank Fuel Heating Study, release date 14 March, 1980.

#4. Transport Fuel Flammability Conference, Washington DC, 7-9 Oct., 1997, FAA/SAE, Proceedings.

#5. FAA Notice of Public Comment, 3 April, 1997, NTSB Recommendations Relating to TWA Flight 800

#6.AAR-00/03, NTSB, In Flight Breakup Over the Atlantic Ocean of Transworld Flight 800, Boeing 747-131,N93119, near East Moriches, NY, 17 July, 1996.

The FTIHWG web site lists the following reference material:

ARAC Tasking Record, dated July, 2000
Terms of Reference, dated July, 2000
FAR Part 25 – Fuel System, dated March 17, 1977
Thermal Modeling to Predict Fuel Tank Flammability, dated 10/07/97
Fuel System In-Tank Design Philosophy on Boeing Aircraft, dated 10/07/97
Fuel System In-Tank Design Philosophy on Airbus Aircraft, dated 10/07/97
1998 ARAC FTHWG Final Report, dated 1998
Fleet Statistics, dated 4/17/98
Airplane Standard Worksheets and Charts, dated 4/17/98
Explosion of JET A Vapor by J.E. Shepherd, dated 10/7/97
Ivor Thomas's Presentation at FAA Technical Center, dated 10/18/00

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Performance of a DC-9 Liquid Nitrogen System, dated August, 1972
Ivor Thomas's Thermal Model, dated 12/01/00, 1/12/01, 3/14/01
The Cost of Implementing Ground-Based Fuel Tank Inerting in the Commercial Fleet, dated May, 2000
A Benefit Analysis for Nitrogen Inerting of Aircraft Fuel Tanks Against Ground Fire Explosion, dated December, 1999
A Review of the Flammability Hazard of Jet A Fuel Vapor in Civil Transport Aircraft Fuel Tanks, dated June, 1998
Evaluate the Effectiveness of Ground-Based Fuel Tank Inerting During Airplane Ground and Flight Operations (Boeing 737 Test Plan), dated Feb. 11, 2002
Airport Survey – Buffalo, dated 1/4/01
Airport Survey – LAX, dated 1/4/01

b) An identification must be made of those individuals and their associated organizations that participated in the writing of the report and their specific contribution.

Response:
The ARAC Working Group members were chosen from resumes submitted to the FAA. The FAA and members of the Chairman of the ARAC Executive Committee met and selected the members of the Working Group. The selected candidates were determined to be capable of addressing all aspects in the Terms of Reference. There were selected for two reasons: they had the skills, background, and capabilities to fully address the task and they represented a balanced range of industry opinions.

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Name	Representing	Company	Contribution
Brad Moravec	Aerospace Industries Association (AIA)	The Boeing Company	Economic and Forecasting Team
Sean O'Callaghan	Association of European Airlines (AEA)	British Airways	Airline Operations and Maintenance Team and Safety Team
G. Michael Collins	Federal Aviation Administration (FAA)	FAA, Transport Airplane Directorate	Rulemaking Team
Laurent Gruz	Joint Aviation Authorities (JAA)	Direction Générale de l'Aviation Civile (France) (DGAC)	Rulemaking Team
Anne Jany	European Association of Aerospace Industries (AECMA)	Airbus	Rulemaking Team
James Hurd (Alternate)	Public Interest Groups	National Air Disaster Alliance / Foundation (NADA / F)	At Large
C. William Kauffman	Public Interest Groups	National Air Disaster Alliance / Foundation (NADA / F)	At Large
Charlie Osonitsch	Small Transport Aircraft Manufacturer	Gulfstream Aerospace	Airplane Design Team
Karl Beers	Inert Gas Equipment Manufacturers	Air Liquide - MEDAL	Airplane Design Team
Brian Sutton	Airline Pilots Association International (ALPA)	TWA	Airline Operations and Maintenance Team
Frank O'Neill	Air Transport Association (ATA)	United Airlines	Airport Facility Team
Jay Hiles	International Association of Machinists (IAM)	US Airways	Airline Operations and Maintenance Team
David Lotterer	Regional Airline Association (RAA)	RAA	At large
Ted Campbell	American Petroleum Inst.(API)	Texaco	Airport Facility Team

c) Under the analysis of benefits, no consideration was given to the adverse impact upon ticket sales after next fuel tank explosion, the cost of family breakups which invariably result when a family member is lost in an air disaster, and the payment of considerable punitive damages by the air transport industry which will result after the next fuel tank explosion. The final version of this report does put the industry on notice regarding a known dangerous but fixable situation. On 17 August, 01, $480M in damages were awarded against Cessna Aircraft Co. regarding an alleged known defect concerning the failure of seat positioning locks.

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Response:
The Tasking Statement required that we evaluate designs based on the FAA's regulatory evaluation methodology, the items listed above fall outside the scope of the evaluation. The Working Group used FAA's methodology and the best cost and benefit data available. If other data or new methods become available then analysis should be reevaluated.

d) A survey of the performance parameters of existing operational inerting systems, particularly on military aircraft (C-5, C-17, F-22, Osprey) where weight, space, and power penalties are especially severe, should be provided and discussed.

Response:
List of performance parameters sent by Bill Kauffman to Greg H on 12/6

At this time, the Air Force and Navy are in the approval process for the release of data.

We have members who are familiar with the systems participating on the team.

Question 2

The question of appropriateness for doing a cost/benefit analysis must be addressed. In three other situations involving the substantial loss of life this seems not to have been an issue: 1) In the Our Lady of Angels, Chicago IL, 1958 school fire resulting in 110 dead an immediate sprinkler and call box installation was initiated and completed within 2 years for all Chicago schools. B) More recently for the past several years Ford Explorer rollovers, presumably initiated by defective tires, have resulted in over 200 deaths. An expenditure of approximately $4B has been made, by only two corporations, as a result of recalls to correct this problem. C) Additionally, at present there is a massive recall of faulty fire sprinkler heads by one manufacturer. It has not been noted that a CBA has been done in order to justify the recall. In a California automobile fuel tank fire case, enormous damages were awarded to the injured in a jury trial as General Motors had reportedly decided that the $8 cost per vehicle required for fuel system redesign and manufacture was not cost effective compared to damages that would be awarded in a trial. In a ruling in the recently completed term, the US Supreme Court judged unanimously in a USEPA related case that only public health (safety?) could be considered and not cost regarding new clean air standards.

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Response:

The Tasking Statement required that we evaluate designs based on the FAA's regulatory evaluation requirements, the items listed above fall outside the scope of the required evaluation. The above general comments are outside of the ARAC Fuel Tank Inerting Harmonization Working Group's Tasking Statement issued by the FAA and will not be answered by this Working Group.

The benefits included the DOT's latest estimate of the amount society would pay to prevent a potential fatality. This value, which is periodically revised to account for inflation, is based on a survey performed by the Urban Institute (The Cost of Highway Crashes, June 1991) of studies that have estimated the amounts society is willing to pay for reduced risk of fatalities. The willingness to pay approach attempts to value an average of all the benefits arising from the prevention of a fatality.

Question 3

No discussion is provided concerning the failure of the strategy to control ignition sources only for the prevention of fuel air explosions (FAE). For FAE where the governing physics is best described by the explosion pentagon – fuel, air, ignition source (these three are considered to be the fire triangle), mixing the fuel and air, and confinement. Experience in other industries (process, coal mining, and grain and feed) has shown that while the control of ignition sources may decrease the number of incidents it does not eliminate them. These industries have also adopted the strategy to control fuel, and the combined effect has been to almost totally eliminate fuel air explosions. Considering that in the three most recent aircraft fuel tank explosions in which the ignition sources have not been identified it is undoubtedly not realistic to assign any numerical value to the possible future effect of SFAR88. Actually, some scenarios could be devised giving negative values for its effect.

Response:
To address the issue of SFAR 88 effectiveness in preventing future accidents, the Working Group considered three effectiveness values in the sensitivity analysis, 25%, 75% and 90%. There are a limited number of potential ignition sources in the fuel system. SFAR 88 will address all of these potential sources.

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With today's technology level, the Working Group could not recommend an inerting system that met the FAA's evaluation requirements. However, the Working Group recommended further research in order to develop a practical inerting system.

Question 4

The projected cost of fuel tank inerting as estimated recently (July 98, ARAC1, $4B; May 2000, FAA, $1.6B; August 2001, ARAC2, $10.4B) varies too widely to provide any confidence. It far exceeds the rate of inflation. New technology driven by such a market opportunity would have a significant impact upon lowering the cost. (The cost of PC's has been significantly lowered by technology and demand.) Additionally, substantial infrastructure costs will be borne by the nitrogen supply contractors as is the case with aviation fuel. Liquid nitrogen systems seem to offer significant cost advantages, but they have been neglected. At the Aril 01 Ex Com meeting, it was recommended explicitly to the Working Group that cryogenic nitrogen systems be considered. Manipulation and slight annotation of the information presented in the report allows the CBR to be lowered to a value of 4.0. Normalization of the costs by other parameters such as passenger flight miles, segments, tickets, etc. makes it almost inconsequential - $0.25 to $1.25. The cost indicated for a future incident of $480M is at least low by a factor of two. TWA 800 estimates were around $1B.

Response:
The three studies mentioned above all used different evaluation periods and other economic assumptions. The 1998 ARAC study and the FAA's study used 10-year evaluation periods. This study used a 16-year evaluation period. Although a longer evaluation period gives a higher total cost it produces a lower cost-benefit ratio. These differences are explained in Appendix G.

As requested by the Executive Committee, a liquid nitrogen system was evaluated and included in Appendix G. The Working Group is not aware of the calculations that lower the Cost-Benefit Ratio to of any of the proposed systems to 4.0. The Working Group would welcome any cost savings suggestions.

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The loss of life is typically the largest component of the overall cost of a catastrophic accident. This cost was determined based on the number of passengers onboard as given in Figure 4-4, and the accidents avoided as given in Figure 4-5. Note that roughly 1 accident is forecast to be avoided, however, that accident is divided between the Large, Medium and Small transports based on their relative risk. The Small transport has the largest forecast fraction of avoided accidents, and has the smallest passenger payload of the three transports. Although the total cost of the TWA 800 accident was not available to the Working Group, some of the known costs were used in this study.

The FAA's evaluation methodology compares the costs and benefits of proposed rulemaking. Although the cost per ticket is one way to scale the total costs, it is not part of the evaluation methodology.

Question 5

All known gas turbine transport aircraft fuel tank explosion incidents should be listed. It is anticipated that this number can be as big as 34. The 17 used by the Working Group may be noted as well as the reasons for their inclusion as well as the exclusion of others.

Response:
All known fuel tank explosion accidents were included in the study. The tasking statement required that the set of accidents defined in the 1998 Fuel Tank Harmonization Working Group Final Report be used by the FTIHWG. There were 16 accidents in that set and a 17th (the Bangkok accident) was added. These accidents represent those involving internal or external ignition sources (other than those associated with ground fire explosion). In addition the tasking statement required that the benefits associated with ground fire explosion be evaluated. The tasking statement suggested DOT/FAA/AR-99/73, "A Benefit Analysis for Nitrogen Inerting of Aircraft Fuel Tanks Against Ground Fire Explosion" be used as a reference. That report included analysis of an additional 13 accidents. So, a total of 30 accidents were included in the analysis.

Question 6

Fuel tank explosions are a single point failure – an energy release of sufficient magnitude into a combustible fuel air mixture. In aviation such a scenario is not acceptable. Inerting of the vapor mixture is a highly specific totally directed fix for this dangerous condition. The nitrogen inerting of fuel tanks is noted to be 100% effective in eliminating fuel vapor air explosions within aircraft fuel tanks. Should aircraft with such a defect continue to be certified?

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Response:
Aircraft fuel systems are designed to preclude single point failures and multiple failures, which would result in an ignition source. Multiple failures are typically necessary for scenarios that would result in an ignition source in a fuel tank. It should also be noted that changes have been introduced since 1996, and other changes will result from SFAR88, that will increase the number of failures necessary for an ignition source to enter a fuel tank.

Also as stated in reply to question 2 and 3, the finding that the inerting technology did not provide benefits that are reasonably justified by the costs, does not mean flammability reduction should be abandoned. It was recommended by the Working Group that other methods of flammability reduction be considered further. For airplanes that apply for type certification after June 6, 2001, the new requirements of CFR 14 Part 25.981(c) will apply.

Question 7

A risk analysis relating to the different types of aircraft needs to be conducted so as to propose an intelligent implementation of an inerting program – begin with the high-risk aircraft, ignore the low risk aircraft.

Response:
Agreed, however the analysis necessary to answer the above question would require significant additional resources, time and effort by the FTIHWG. The FAA should consider this as part of any potential rulemaking.

Question 8

All methods that would decrease fuel tank flammability need to be examined and evaluated, especially those that may be quickly and cheaply implemented: like suppression, expanded metal mesh, and JP-5 fuel. Such was briefly introduced at the end of the Ex Com, 8 August 01, presentation.

Response:

Agreed. The tasking of this Working Group was limited to the study of inerting systems. Nevertheless, alternatives to inerting, which were evaluated as part of the 1998 ARAC study, should be studied further.

Question 9

The NTSB supports fuel tank inerting. On 8 August, 01, Carol Carmody, acting chair, expressed her disappointment that the Working Group used CBA to recommend that fuel tank inerting not be implemented. On 23 August, 2000, the past chair, Jim Hall, noted that "it is imperative at long last, the aviation community move with dispatch to remove flammable fuel/air mixtures from the fuel tanks of transport category aircraft" as

recommended to the FAA by the CAB on 17 December, 1963 as a result of the Pan Am flight 214 disaster. Do the NTSB and CAB have privileged expertise or data that would allow them to arrive at a different conclusion from the Working Group?

Response:

NTSB specialists participated as observers; any information from the NTSB would be welcomed

The Cost-Benefit analysis is a step in the rulemaking evaluation process. The Working Group could not recommend new rulemaking because inerting systems designed with today's technology would not meet the evaluation requirements. The working group recommended further research with the expectation that new technology would produce a practical system.

Question 10

OSHA data for nitrogen asphyxiation in the workplace for 13 years (1984-1996) gives 61 accidental deaths resulting in an average of 4.69 deaths per year. It should be noted that the great majority of the situations did not involve the level of training and technology that is employed in the air transportation industry. This data should be adjusted on the estimated percentage of national nitrogen consumption to be used for fuel tank inerting.

Response:

The FTIHWG lacked the time and expertise to assess these risks with confidence. However, the FTIHWG felt it was important to bind the risk. To do this, a simple extrapolation of available Occupational Safety and Health Administration (OSHA) and National Institute of Occupational Safety and Health (NIOSH) data was used. Based on 1980-1989 NIOSH data, the confined space accident rate is between 0.20 (for the

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transportation industry) and 0.68 (for the Oil and Gas industry) per 100 thousand employees. Of these, 43% were due to "Hazardous Atmosphere - O2 deficiency." Assuming that these were all inert gas related (Argon, Nitrogen, CO2, etc) would result in a confined space asphyxiation rate of 0.086 to 0.292 per 100 thousand employees. According to OSHA, there were 1.2431 million US airline employees in 1999. This would suggest the US airline industry could expect 1.07 to 3.6 fatalities per year. However, in 1993 OSHA implemented more rigorous confined space permit rules and estimated those rules would reduce fatalities by 85% in the US. Assuming these rules are as effective as initially estimated reduces the US airline industry fatalities per year to 0.16 to 0.54. The US accounts for approximately 46% of worldwide airplane operations, and it was assumed that an OSHA equivalent confined space regulation did not exist in the rest of the world. That results in a non-US airline industry fatality rate of 1.26 to 4.23. The range then for the total worldwide airline industry fatality rate is 1.42 to 4.77

fatalities per year due to confined space asphyxiation from Nitrogen. Based on the assumed annual fleet growth rates and inerting system implementation assumptions, it is forecast that a total of 24 to 81 lives may be lost over the study period due to this risk. The FTIHWG did not have participation from OSHA or NIOSH. It is recommended that those agencies evaluate this risk based on current data before implementing inerting on a global scale.